# NUTRITIONAL PROBLEMS OF ADVANCING AGE*

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Two important health problems of advancing age are obesity and atherosclerosis. Our Department of Nutrition at Harvard has active researches in both areas and we feel both problems are basically nutritional in their origin. I should like to tell you briefly about some of our recent findings in these studies. I am sure you must all be aware that most of what I shall relate is the work of a number of hardworking colleagues and graduate students, and not my own. Also that by telling only of our work I do not mean to imply that others are not actively working on these problems. But my time is limited, it's easier to tell you about our own work and obviously we think it important or we would be doing something else.

We have done a great many studies of various aspects of obesity during the past ten years in both man and a number of different types of animals. Generally my colleague, Dr. Mayer, has directed the animal studies and Dr. Trulson has had charge of the studies with man.

A simple study which has only recently been prepared for publication involves the role of non-caloric sweeteners in overweight subjects. This may have some practical interest to some of you.

Two groups of individuals were questioned about their use of non-caloric sweeteners and artificially sweetened products. Group I was composed of 147 obese individuals who were subjects in a three-year follow-up study of the effectiveness (or really lack of effectiveness) of various reducing programs. Group II consisted of 100 obese patients referred to the nutrition clinic of the Peter Bent Brigham Hospital in Boston and who were followed a relatively short time.

Thus there were 247 obese subjects. Of this number, 105 were using or had used non-caloric sweeteners and/or artificially sweetened prod-

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TABLE I.—THREE YEAR WEIGHT STUDY

| *147 Obese Subjects* | *Non-Caloric Sweeteners* | |
|---|---|---|
| | *Yes* | *No* |
| No. of Subjects who Lost Weight | 47 | 49 |
| No. of Subjects who Gained Weight or had the Same Weight | 25 | 26 |

ucts. To attempt to determine the effectiveness in weight reduction of the use of non-caloric sweeteners, the data from the follow-up study on Group I were analyzed with respect to weight loss and the use or non-use of non-caloric sweeteners. About one-half of these subjects were using or had used these products. The subjects' weights before the instigation of the weight reduction program and at the time of the three-year follow-up study were tabulated. The percentage of the initial per cent overweight lost or gained was determined. Sixty-five per cent of both groups (users and non-users) had at some time during the three-year period lost some weight. Usually this was during the first two months of starting to reduce. No difference in weight loss between those that had used non-caloric sweeteners and those that had not was apparent. The results are summarized in Table I.

A study was made of the length of time non-caloric sweeteners were used and weight loss. It was found that the length of time the products were used did not alter the weight change pattern.

Of the 100 obese patients in the hospital clinic group, 33 were users of non-caloric sweeteners. The weight loss of these subjects while using non-caloric sweeteners and artificially sweetened products was not evaluated because of the short time the individuals had been on the reduction regime and because the accuracy of the reported weight loss would depend upon the reliability of the patients' memory and their wish to be accurate. However, of the 33 patients who had used the product 11 believed they lost weight and had received definite help from employing such products and 22 said they had either gained weight or their weight had remained the same.

An attempt was made to find out if the degree of overweight was associated with the use of non-caloric sweeteners. Of the total number

of 247 subjects, 67 were 50 per cent or more above their desirable weight, and of these, 36 used non-caloric sweeteners, and 31 did not. No relationship between degree of overweight and the use of non-caloric sweeteners was evident.

Generally the use of non-caloric sweeteners by the obese subjects was limited to sweetening tea and coffee and occasionally cereal, dessert, and fruit. The actual use of artificially sweetened foods by this group was small as compared with a group of diabetic patients we were also studying.

By and large, weight reduction regimes when considered from the long-range point of view are quite unsuccessful. Many aspects of obesity are yet unknown or little understood. Certainly little is known of methods of motivation that are effective over an extended period of time. It is obvious that there is no one key to the problem of obesity. The use of non-caloric sweeteners and artificially sweetened foods when considered on a group basis is not of particular value in a reducing program. However, it is well to remember that it is the individual who is losing weight, not the group. Therefore, if one out of four or five individuals is helped to some extent, the use of non-caloric sweeteners may have a place in the diets of some obese individuals.

The preventive aspects of weight control should be stressed since most attempts at long-term weight control along curative lines have so far failed. The old saying, "An ounce of prevention is worth a pound of cure", is certainly true in the problem of obesity, an important problem in advancing age.

It might be of interest to simply mention a number of specific suggestions which we have evolved as a result of researches in both animals and man and that may be of some practical importance in dealing with this problem in man.

1. Prevention is better than treatment.
2. Early treatment is better than late treatment.
3. Parents should set good examples for their children. If they eat like gluttons, what can you expect of the children?
4. Use the bathroom scales—weekly or monthly and keep a written record of weight.
5. Eat 3 meals a day—a good breakfast—eat in the daytime, not at night.

6. Eat slowly. This allows the blood sugar to rise and satisfy the appetite before it is time for "seconds."
7. Cut down on the total food. It is not necessary to eliminate any single food.
8. Take your choice between cocktails or dessert.
9. If necessary, use "scientific nibbles," not "common nibbles," to help curb your appetite.
10. Mild to moderate daily exercise is helpful.

Please remember these are suggestions not all documented by firm evidence, but they may be helpful to those who have to struggle with an overweight problem.

Next, a few interesting findings related to atherosclerosis, particularly some relatively new and positive findings on the importance of exercise in the disposition of food calories. These studies have been done by my colleague, Dr. Mann, and are being extended largely by Drs. Hegsted, Portman, and Andrus of our Department.

Atherosclerosis is certainly an important problem of advancing age and one where there is a strong nutritional component. Not only is it a problem of advancing age but a problem of middle age as well, and it is a problem which within the last month has received considerable public attention.

The evidence relating the level of the serum lipids to the etiology of experimental atherosclerosis in animals is pretty strong. I believe atherosclerosis has now been produced experimentally in five different species,—the rabbit, chick, dog, rat, and in a primate, the Cebus monkey. The presence of atherosclerosis has been reported in other species, such as the pig, but I am not aware that it has been produced experimentally in any species other than the five I have listed. In all of these it was necessary to find a procedure whereby the serum cholesterol, and the other serum lipids, could be elevated for a certain length of time. There seems to be an intensity and a time factor—the level of the serum lipids and the time they are elevated.

The development of refined biophysical methods for the characterization of serum lipids has not greatly clarified this serum lipid-disease relationship although the new methods have emphasized a lack of correlation between the serum cholesterol and lipoprotein quantities in human subjects which was unexpected in view of the biochemical sim-

ilarities of the two and the close correlations which are found in subhuman animals that have been studied both before and after hypercholesteremia was induced.

We cooperated with the Institute of Nutrition of Central America in a study of the lipid levels of Guatemalan subjects subsisting largely upon vegetarian diets. These researches[1] revealed an unexpected dissociation of the serum beta-lipoprotein and cholesterol levels. These subjects showed low and almost constant cholesterol levels at all adult ages. The levels, which were near 150 mg. per cent for both sexes, of that adult population, are characteristic of North American children. In contrast, the serum beta-lipoprotein levels in the Central American subjects were similar to those of the North American subjects when compared according to age and sex. It became of interest to examine the hypotheses that some characteristic of the environment of the Guatemalans might account for these observations. There were two conspicuous differences between the study groups: 1) The Central Americans were found to eat much less fat than the North Americans. While it has been shown that limitation of dietary fat will often lead to a reduction of the serum cholesterol and serum beta-lipoprotein levels, there has been no evidence produced that this treatment will selectively lower the cholesterol level, leaving the beta-lipoproteins unchanged or even increased as would be necessary to explain the Central American findings. 2) The studies in Central America indicated that while those subjects were thinner than age- and sex-matched North Americans, the Central Americans consumed more food daily in relation to body size. These facts could only mean that high energy expenditures by the rural Central Americans must account for the weight differences. This conclusion was consonant with the vigorous activity required of individuals in that agrarian culture. We were thus led to consider that there might be some favorable effect of muscular exercise upon the regulation of the serum lipids which selectively keeps the serum cholesterol level low.

Other studies[2] we have done with adult American males have indicated that under certain conditions changes in weight affect the serum lipids. Thus, we have shown that a period of weight loss in human subjects will result in a reduction of the levels of serum lipoproteins and cholesterol *but only if these were initially elevated.* Conversely, we showed that a short period of rapid weight gain even if

accomplished on a low fat, low cholesterol diet increased both of those serum lipid components.

We recently completed a somewhat similar, but more elaborate study, to which a vigorous exercise component was added.[3]

Four medical students were engaged to participate in an experiment of ten weeks' duration. The subjects were paid a good wage in addition to their food, and this was the principal initial motivation of three of the men. The fourth, although also paid, was interested in the experiment.

The men were fed at a research diet table during the entire experiment. Food was served by research dietitians who measured the intake of food. The subjects were observed for the first week under these conditions on an *ad libitum* food intake with their usual physical activity and while maintaining their body weights at a nearly constant level. From these dietary measurements the intakes of fat and total calories were computed and averaged for each subject. In the second period which was of four weeks' duration the caloric intake was approximately doubled while the fat intake was kept constant at the control level, about 175 gm. and the subjects were required to maintain their body weights within five pounds of the mean weight during the control period by *strenuous* daily exercise. This was the high energy expenditure period. In the third period of three weeks' duration, the subjects returned to the control level of energy expenditure but the high calorie and constant fat intake continued thus permitting the deposition of body fat. In the fourth and final period of two weeks' duration, the subjects were restricted in food calories with the dietary fat again remaining constant but the exercise was omitted except for that occasioned by their usual academic activity as in the first and third periods.

The large food intakes of the second period were reached by a stepwise increase over a 48-hour period at the beginning of the period in order to give the subjects time to adapt to this great dietary change. During the seven weeks of high calorie intake, the subjects ate three major meals under observation at the research table and in addition took supplementary feedings consisting principally of measured amounts of candy bars, marshmallows and soft drinks. These supplementary meals furnished 25 to 30 per cent of the total daily calories.

The high energy expenditure was accomplished by a rigorous schedule of daily physical training. The subjects spent three hours every

day engaged in vigorous physical activity in a gymnasium. Swimming, basketball and sprinting proved the most useful activities. These activities were supplemented as necessary by cycling and outdoor running.

Blood was drawn in the post-absorptive state at weekly intervals during the experiment and the serum was used for the measurement of cholesterol and of the beta-lipoproteins.

Three subjects completed the regimen in all details. The fourth subject was unable to maintain a constant weight and retired at the end of the second week of high energy expenditure. It may be of interest to mention that the subject leaving the experiment because of excessive weight gain was a tall, lean individual who initially argued that no one could make him gain weight.

The findings clearly indicated that during the high energy period, despite the large intake of calories, there was no essential change in weight, serum cholesterol, or the lipoprotein fraction measured.

These observations indicate that young men consuming high fat diets were able to double their caloric supply without increasing the level of their serum lipids so long as the excess energy was dissipated as exercise. The findings support the concept that serum lipid levels are related to the calorie balance of the body.

The experiment described may represent in a microcosm the nutritional progress of an adult American male. A period in early adulthood of high energy turnover may then be followed by a long period of diminishing physical activity but with unchanging dietary habits. This leads in a variable time to an obese individual at middle age with poor muscular development, with elevated serum cholesterol and beta-lipoprotein levels, though without visible lipemia. More important, there is generally significant atherosclerosis in such a man. The present experiment may have shortened these simulated phases excessively. By not allowing time for the large changes of body inventory, the full effects upon the serum lipids may have been minimized or obscured. There seems little doubt but that significant effects can be produced on both the body composition and the serum lipids in most subjects by these alterations of diet and physical activity.

After middle age, if this hypothesis is true, we have a patient in advancing physiologic age, with atherosclerosis and its many unpleasant complications.

It would be of interest to know whether a larger sample of this

age, or a sample of older subjects, would have shown a similar degree of response. The two subjects studied previously without the heavy exercise component, each of whom responded promptly to positive calorie balance with increases of the serum lipoproteins and cholesterol, were 27 and 38 years of age. The present subjects were in that age group (24 years) where there is anatomical evidence to indicate that atherogenesis is beginning.

The sera of these subjects which were drawn in the post-absorptive state were clear throughout the experiment. The lack of increase either of neutral fat as measured chemically or of low density beta-lipoproteins measured with the ultracentrifuge conforms with the observation that the serum lipid changes which occur with positive calorie balance and adiposity are of the invisible high density beta-lipoproteins. It should be emphasized that visible lipemia in serum obtained in the post-absorptive state is uncommon in subjects of any age and cannot be a necessary development for the development of atherosclerosis.

The subjective responses of these men to the experiment reveal two observations of possible clinical usefulness. While the first days of physical training produced discomforts and fatigue, the men soon experienced a sense of well-being and accomplishment which they considered adequate compensation for their troubles. During the low exercise, weight gaining period which followed, the men continued to eat the excessive food intakes without complaint and even with some relish, but as they grew fat they became sluggish and, in their own evaluation, less efficient in their daily activities. Nonetheless they were complacent in this progress of obesity. The first reaction may mean that physical conditioning is self-rewarding and sufficient motivation in itself, aside from any desirable effects it may have in preventing atherogenesis. The second reaction indicates that dietary habits, even when of a short duration, have high inertias. This tardiness of adjustment of food intake to metabolic requirements may be based on obscure physiological phenomena which are in addition to the contribution made in real life by social customs, culinary artistry and changing values of a pleasurable activity which occur with age.

## Conclusion

What does all this mean to the practicing physician who is faced with the real problem of advising his older patients about their diet?

Essentially the older person's food needs do not differ from those of the young. A variety of nutritious foods each day are as important to him now as at any time in his life. Precisely because he is older and his tempo of living has slowed, his digestive system has slowed up a bit too. His caloric needs are lower because he is not so active as in his younger days. He may find small meals more comfortable and satisfying than large ones. Chances are that his dentures are not what they used to be. For this reason he may require foods that are easily chewed.

Sound nutrition for the elderly differs only slightly from that of the younger adult. The principal differences are:

1. Fewer calories, and, because of the need for fewer calories, activity somewhat above the maintenance level should be encouraged. Such activity will also stimulate the peripheral circulation, strengthen bones, and improve gastrointestinal activity.

2. A smaller proportion of calories should be contributed by fat and a larger proportion by protein, though current and future researches may indicate that it is the saturated fats which should be consumed in smaller amounts as distinguished from unsaturated fats.

3. Dietary modifications, necessitated by poor dentures, low income, inadequate cooking facilities and poor appetite are often required.

4. Lastly, and probably most important, physicians and others respond best to disability, disease, deficiency, and distress. We must learn to respond equally well to prevention, protection, preservation, and the improvement of health, both personal and public. For these are the principles which if applied *prior* to advancing age will make that period healthier and happier. And here proper nutrition is of most importance.

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